



SEQUENCE LISTING

F<sub>3</sub>  
<110> Svendsen, Allan  
Bisgard-Frantzen, Henrik  
Borchert, Torben Vedel

<120> Alpha-Amylase Mutants

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<140> 09/327,563

<141> 1999-06-08

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aagtgaagaa	gcagagaggc	tattgaataa	atgagtagaa	gcgccatata	ggcgcttttc	240
ttttggaaga	aaatataggg	aaaatggtac	ttgttaaaaa	ttcggaatat	ttatacaaca	300
tcatatgttt	cacattgaaa	ggggaggaga	atc atg aaa	caa caa aaa	cgg ctt	354
			Met Lys Gln Gln Lys Arg Leu			
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Tyr Ala Arg	Leu Leu Thr	Leu Leu Phe	Ala Leu Ile	Phe Leu	Leu Pro	
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His Ser Ala	Ala Ala Ala	Ala Asn Leu	Asn Gly Thr	Leu Met	Gln Tyr	
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TECH CENTER 1600/2900

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Pro Pro Ala Tyr Lys Gly Thr Ser Gln Ala Asp Val Gly Tyr Gly Ala	
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Tyr Asp Leu Tyr Asp Leu Gly Glu Phe His Gln Lys Gly Thr Val Arg	
60 65 70	
aca aag tac ggc aca aaa gga gag ctg caa tct gcg atc aaa agt ctt	690
Thr Lys Tyr Gly Thr Lys Gly Glu Leu Gln Ser Ala Ile Lys Ser Leu	
75 80 85 90	
cat tcc cgc gac att aac gtt tac ggg gat gtg gtc atc aac cac aaa	738
His Ser Arg Asp Ile Asn Val Tyr Gly Asp Val Val Ile Asn His Lys	
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ggc ggc gct gat gcg acc gaa gat gta acc gcg gtt gaa gtc gat ccc	786
Gly Gly Ala Asp Ala Thr Glu Asp Val Thr Ala Val Glu Val Asp Pro	
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gct gac cgc aac cgc gta att tca gga gaa cac cta att aaa gcc tgg	834
Ala Asp Arg Asn Arg Val Ile Ser Gly Glu His Leu Ile Lys Ala Trp	
125 130 135	
aca cat ttt cat ttt ccg ggg cgc ggc agc aca tac agc gat ttt aaa	882
Thr His Phe His Phe Pro Gly Arg Gly Ser Thr Tyr Ser Asp Phe Lys	
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Trp His Trp Tyr His Phe Asp Gly Thr Asp Trp Asp Glu Ser Arg Lys	
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Leu Asn Arg Ile Tyr Lys Phe Gln Gly Lys Ala Trp Asp Trp Glu Val	
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tcc aat gaa aac ggc aac tat gat tat ttg atg tat gcc gac atc gat	1026
Ser Asn Glu Asn Gly Asn Tyr Asp Tyr Leu Met Tyr Ala Asp Ile Asp	
190 195 200	
tat gac cat cct gat gtc gca gca gaa att aag aga tgg ggc act tgg	1074
Tyr Asp His Pro Asp Val Ala Ala Glu Ile Lys Arg Trp Gly Thr Trp	
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Lys	Thr	Gly	Lys	Glu	Met	Phe	Thr	Val	Ala	Glu	Tyr	Trp	Gln	Asn	Asp	
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ttg	ggc	gcg	ctg	gaa	aac	tat	ttg	aac	aaa	aca	aat	ttt	aat	cat	tca	1266
Leu	Gly	Ala	Leu	Glu	Asn	Tyr	Leu	Asn	Lys	Thr	Asn	Phe	Asn	His	Ser	
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Val	Phe	Asp	Val	Pro	Leu	His	Tyr	Gln	Phe	His	Ala	Ala	Ser	Thr	Gln	
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F5 gga	ggc	ggc	tat	gat	atg	agg	aaa	ttg	ctg	aac	ggg	acg	gtc	gtt	tcc	1362
Gly	Gly	Gly	Tyr	Asp	Met	Arg	Lys	Leu	Leu	Asn	Gly	Thr	Val	Val	Ser	
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aag	cat	ccg	ttg	aaa	tcg	gtt	aca	ttt	gtc	gat	aac	cat	gat	aca	cag	1410
Lys	His	Pro	Leu	Lys	Ser	Val	Thr	Phe	Val	Asp	Asn	His	Asp	Thr	Gln	
315					320					325					330	
ccg	ggg	caa	tcg	ctt	gag	tcg	act	gtc	caa	aca	tgg	ttt	aag	ccg	ctt	1458
Pro	Gly	Gln	Ser	Leu	Glu	Ser	Thr	Val	Gln	Thr	Trp	Phe	Lys	Pro	Leu	
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gct	tac	gct	ttt	att	ctc	aca	agg	gaa	tct	gga	tac	cct	cag	gtt	ttc	1506
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Tyr	Gly	Asp	Met	Tyr	Gly	Thr	Lys	Gly	Asp	Ser	Gln	Arg	Glu	Ile	Pro	
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Ala	Leu	Lys	His	Lys	Ile	Glu	Pro	Ile	Leu	Lys	Ala	Arg	Lys	Gln	Tyr	
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Ala	Tyr	Gly	Ala	Gln	His	Asp	Tyr	Phe	Asp	His	His	Asp	Ile	Val	Gly	
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tgg	aca	agg	gaa	ggc	gac	agc	tcg	gtt	gca	aat	tca	ggg	ttg	gcg	gca	1698
Trp	Thr	Arg	Glu	Gly	Asp	Ser	Ser	Val	Ala	Asn	Ser	Gly	Leu	Ala	Ala	
				415					420					425		
tta	ata	aca	gac	gga	ccc	ggg	ggg	gca	aag	cga	atg	tat	gtc	ggc	cgg	1746
Leu	Ile	Thr	Asp	Gly	Pro	Gly	Gly	Ala	Lys	Arg	Met	Tyr	Val	Gly	Arg	
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Gln Asn Ala Gly Glu Thr Trp His Asp Ile Thr Gly Asn Arg Ser Glu  
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Pro Val Val Ile Asn Ser Glu Gly Trp Gly Glu Phe His Val Asn Gly  
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ggg tcg gtt tca att tat gtt caa aga tagaagagca gagaggacgg 1889  
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Asn Gly Thr Leu Met Gln Tyr Phe Glu Trp Tyr Met Pro Asn Asp Gly  
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Gln His Trp Arg Arg Leu Gln Asn Asp Ser Ala Tyr Leu Ala Glu His  
50 55 60  
Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Tyr Lys Gly Thr Ser Gln  
65 70 75 80  
Ala Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr Asp Leu Gly Glu Phe  
85 90 95  
His Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys Gly Glu Leu  
100 105 110  
Gln Ser Ala Ile Lys Ser Leu His Ser Arg Asp Ile Asn Val Tyr Gly  
115 120 125  
Asp Val Val Ile Asn His Lys Gly Gly Ala Asp Ala Thr Glu Asp Val  
130 135 140  
Thr Ala Val Glu Val Asp Pro Ala Asp Arg Asn Arg Val Ile Ser Gly  
145 150 155 160  
Glu His Leu Ile Lys Ala Trp Thr His Phe His Phe Pro Gly Arg Gly  
165 170 175  
Ser Thr Tyr Ser Asp Phe Lys Trp His Trp Tyr His Phe Asp Gly Thr  
180 185 190  
Asp Trp Asp Glu Ser Arg Lys Leu Asn Arg Ile Tyr Lys Phe Gln Gly  
195 200 205  
Lys Ala Trp Asp Trp Glu Val Ser Asn Glu Asn Gly Asn Tyr Asp Tyr  
210 215 220  
Leu Met Tyr Ala Asp Ile Asp Tyr Asp His Pro Asp Val Ala Ala Glu  
225 230 235 240  
Ile Lys Arg Trp Gly Thr Trp Tyr Ala Asn Glu Leu Gln Leu Asp Gly  
245 250 255  
Phe Arg Leu Asp Ala Val Lys His Ile Lys Phe Ser Phe Leu Arg Asp



-30

-25

-20

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Leu	Met	Cys	Thr	Leu	Leu	Phe	Val	Ser	Leu	Pro	Ile	Thr	Lys	Thr	Ser	
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Ala	Val	Asn	Gly	Thr	Leu	Met	Gln	Tyr	Phe	Glu	Trp	Tyr	Thr	Pro	Asn	
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gac	ggc	cag	cat	tgg	aaa	cga	ttg	cag	aat	gat	gcg	gaa	cat	tta	tcg	435
Asp	Gly	Gln	His	Trp	Lys	Arg	Leu	Gln	Asn	Asp	Ala	Glu	His	Leu	Ser	
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gat	atc	gga	atc	act	gcc	gtc	tgg	att	cct	ccc	gca	tac	aaa	gga	ttg	483
Asp	Ile	Gly	Ile	Thr	Ala	Val	Trp	Ile	Pro	Pro	Ala	Tyr	Lys	Gly	Leu	
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Ser	Gln	Ser	Asp	Asn	Gly	Tyr	Gly	Pro	Tyr	Asp	Leu	Tyr	Asp	Leu	Gly	
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Glu	Phe	Gln	Gln	Lys	Gly	Thr	Val	Arg	Thr	Lys	Tyr	Gly	Thr	Lys	Ser	
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Glu	Leu	Gln	Asp	Ala	Ile	Gly	Ser	Leu	His	Ser	Arg	Asn	Val	Gln	Val	
	80				85					90					95	
tac	gga	gat	gtg	gtt	ttg	aat	cat	aag	gct	ggg	gct	gat	gca	aca	gaa	675
Tyr	Gly	Asp	Val	Val	Leu	Asn	His	Lys	Ala	Gly	Ala	Asp	Ala	Thr	Glu	
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gat	gta	act	gcc	gtc	gaa	gtc	aat	ccg	gcc	aat	aga	aat	cag	gaa	act	723
Asp	Val	Thr	Ala	Val	Glu	Val	Asn	Pro	Ala	Asn	Arg	Asn	Gln	Glu	Thr	
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tcg	gag	gaa	tat	caa	atc	aaa	gcg	tgg	acg	gat	ttt	cgt	ttt	ccg	ggc	771
Ser	Glu	Glu	Tyr	Gln	Ile	Lys	Ala	Trp	Thr	Asp	Phe	Arg	Phe	Pro	Gly	
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Arg	Gly	Asn	Thr	Tyr	Ser	Asp	Phe	Lys	Trp	His	Trp	Tyr	His	Phe	Asp	
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Gly	Ala	Asp	Trp	Asp	Glu	Ser	Arg	Lys	Ile	Ser	Arg	Ile	Phe	Lys	Phe	
	160				165					170					175	
cgt	ggg	gaa	gga	aaa	gcg	tgg	gat	tgg	gaa	gta	tca	agt	gaa	aac	ggc	915
Arg	Gly	Glu	Gly	Lys	Ala	Trp	Asp	Trp	Glu	Val	Ser	Ser	Glu	Asn	Gly	
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gtc	gtg	gca	gag	aca	aaa	aaa	tgg	ggc	atc	tgg	tat	gcg	aat	gaa	ctg	1011
Val	Val	Ala	Glu	Thr	Lys	Lys	Trp	Gly	Ile	Trp	Tyr	Ala	Asn	Glu	Leu	
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tca	tta	gac	ggc	ttc	cgt	att	gat	gcc	gcc	aaa	cat	att	aaa	ttt	tca	1059
Ser	Leu	Asp	Gly	Phe	Arg	Ile	Asp	Ala	Ala	Lys	His	Ile	Lys	Phe	Ser	
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ttt	ctg	cgt	gat	tgg	gtt	cag	gcg	gtc	aga	cag	gcg	acg	gga	aaa	gaa	1107
Phe	Leu	Arg	Asp	Trp	Val	Gln	Ala	Val	Arg	Gln	Ala	Thr	Gly	Lys	Glu	
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atg	ttt	acg	gtt	gcg	gag	tat	tgg	cag	aat	aat	gcc	ggg	aaa	ctc	gaa	1155
Met	Phe	Thr	Val	Ala	Glu	Tyr	Trp	Gln	Asn	Asn	Ala	Gly	Lys	Leu	Glu	
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aac	tac	ttg	aat	aaa	aca	agc	ttt	aat	caa	tcc	gtg	ttt	gat	gtt	ccg	1203
Asn	Tyr	Leu	Asn	Lys	Thr	Ser	Phe	Asn	Gln	Ser	Val	Phe	Asp	Val	Pro	
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ctt	cat	ttc	aat	tta	cag	gcg	gct	tcc	tca	caa	gga	ggc	gga	tat	gat	1251
Leu	His	Phe	Asn	Leu	Gln	Ala	Ala	Ser	Ser	Gln	Gly	Gly	Gly	Tyr	Asp	
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Met	Arg	Arg	Leu	Leu	Asp	Gly	Thr	Val	Val	Ser	Arg	His	Pro	Glu	Lys	
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Ala	Val	Thr	Phe	Val	Glu	Asn	His	Asp	Thr	Gln	Pro	Gly	Gln	Ser	Leu	
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gaa	tcg	aca	gtc	caa	act	tgg	ttt	aaa	ccg	ctt	gca	tac	gcc	ttt	att	1395
Glu	Ser	Thr	Val	Gln	Thr	Trp	Phe	Lys	Pro	Leu	Ala	Tyr	Ala	Phe	Ile	
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Leu	Thr	Arg	Glu	Ser	Gly	Tyr	Pro	Gln	Val	Phe	Tyr	Gly	Asp	Met	Tyr	
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Gly	Thr	Lys	Gly	Thr	Ser	Pro	Lys	Glu	Ile	Pro	Ser	Leu	Lys	Asp	Asn	
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Ile	Glu	Pro	Ile	Leu	Lys	Ala	Arg	Lys	Glu	Tyr	Ala	Tyr	Gly	Pro	Gln	
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F5

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Asp Ser Ser Ala Ala Lys Ser Gly Leu Ala Ala Leu Ile Thr Asp Gly				
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ccc ggc gga tca aag cgg atg tat gcc ggc ctg aaa aat gcc ggc gag				1683
Pro Gly Gly Ser Lys Arg Met Tyr Ala Gly Leu Lys Asn Ala Gly Glu				
	435	440	445	
aca tgg tat gac ata acg ggc aac cgt tca gat act gta aaa atc gga				1731
Thr Trp Tyr Asp Ile Thr Gly Asn Arg Ser Asp Thr Val Lys Ile Gly				
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tct gac ggc tgg gga gag ttt cat gta aac gat ggg tcc gtc tcc att				1779
Ser Asp Gly Trp Gly Glu Phe His Val Asn Asp Gly Ser Val Ser Ile				
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35 40 45				
Gln His Trp Lys Arg Leu Gln Asn Asp Ala Glu His Leu Ser Asp Ile				
50 55 60				
Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Tyr Lys Gly Leu Ser Gln				
65 70 75 80				
Ser Asp Asn Gly Tyr Gly Pro Tyr Asp Leu Tyr Asp Leu Gly Glu Phe				
85 90 95				
Gln Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys Ser Glu Leu				
100 105 110				
Gln Asp Ala Ile Gly Ser Leu His Ser Arg Asn Val Gln Val Tyr Gly				
115 120 125				
Asp Val Val Leu Asn His Lys Ala Gly Ala Asp Ala Thr Glu Asp Val				
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Thr Ala Val Glu Val Asn Pro Ala Asn Arg Asn Gln Glu Thr Ser Glu				
145 150 155 160				



F5

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Asp	Tyr	Leu	Met	Tyr	Ala	Asp	Val	Asp	Tyr	Asp	His	Pro	Asp	Val	Val		
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Asp	Gly	Phe	Arg	Ile	Asp	Ala	Ala	Lys	His	Ile	Lys	Phe	Ser	Phe	Leu		
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385					390					395					400		
Lys	Gly	Thr	Ser	Pro	Lys	Glu	Ile	Pro	Ser	Leu	Lys	Asp	Asn	Ile	Glu		
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Pro	Ile	Leu	Lys	Ala	Arg	Lys	Glu	Tyr	Ala	Tyr	Gly	Pro	Gln	His	Asp		
			420					425					430				
Tyr	Ile	Asp	His	Pro	Asp	Val	Ile	Gly	Trp	Thr	Arg	Glu	Gly	Asp	Ser		
		435					440					445					
Ser	Ala	Ala	Lys	Ser	Gly	Leu	Ala	Ala	Leu	Ile	Thr	Asp	Gly	Pro	Gly		
	450					455					460						
Gly	Ser	Lys	Arg	Met	Tyr	Ala	Gly	Leu	Lys	Asn	Ala	Gly	Glu	Thr	Trp		
465					470					475					480		
Tyr	Asp	Ile	Thr	Gly	Asn	Arg	Ser	Asp	Thr	Val	Lys	Ile	Gly	Ser	Asp		
			485					490					495				
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Gln	Lys																

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<222> (156)...(257)

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<222> (258)...(1802)

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tcgaatgtaa	catttgatta	agggggaagg	gcatt	gtg	cta	acg ttt cac cgc	173

Val Leu Thr Phe His Arg  
-30

atc	att	cga	aaa	gga	tgg	atg	ttc	ctg	ctc	gcg	ttt	ttg	ctc	act	gtc	221
Ile	Ile	Arg	Lys	Gly	Trp	Met	Phe	Leu	Leu	Ala	Phe	Leu	Leu	Thr	Val	
			-25					-20					-15			

F5

tcg	ctg	ttc	tgc	cca	aca	gga	cag	ccc	gcc	aag	gct	gcc	gca	ccg	ttt	269
Ser	Leu	Phe	Cys	Pro	Thr	Gly	Gln	Pro	Ala	Lys	Ala	Ala	Ala	Pro	Phe	
		-10					-5					1				

aac	ggc	acc	atg	atg	cag	tat	ttt	gaa	tgg	tac	ttg	ccg	gat	gat	ggc	317
Asn	Gly	Thr	Met	Met	Gln	Tyr	Phe	Glu	Trp	Tyr	Leu	Pro	Asp	Asp	Gly	
5					10					15					20	

acg	tta	tgg	acc	aaa	gtg	gcc	aat	gaa	gcc	aac	aac	tta	tcc	agc	ctt	365
Thr	Leu	Trp	Thr	Lys	Val	Ala	Asn	Glu	Ala	Asn	Asn	Leu	Ser	Ser	Leu	
			25						30					35		

ggc	atc	acc	gct	ctt	tgg	ctg	ccg	ccc	gct	tac	aaa	gga	aca	agc	cgc	413
Gly	Ile	Thr	Ala	Leu	Trp	Leu	Pro	Pro	Ala	Tyr	Lys	Gly	Thr	Ser	Arg	
			40					45					50			

agc	gac	gta	ggg	tac	gga	gta	tac	gac	ttg	tat	gac	ctc	ggc	gaa	ttc	461
Ser	Asp	Val	Gly	Tyr	Gly	Val	Tyr	Asp	Leu	Tyr	Asp	Leu	Gly	Glu	Phe	
		55					60					65				

aat	caa	aaa	ggg	acc	gtc	cgc	aca	aaa	tac	gga	aca	aaa	gct	caa	tat	509
Asn	Gln	Lys	Gly	Thr	Val	Arg	Thr	Lys	Tyr	Gly	Thr	Lys	Ala	Gln	Tyr	
	70					75					80					

ctt	caa	gcc	att	caa	gcc	gcc	cac	gcc	gct	gga	atg	caa	gtg	tac	gcc	557
Leu	Gln	Ala	Ile	Gln	Ala	Ala	His	Ala	Ala	Gly	Met	Gln	Val	Tyr	Ala	
85				90						95					100	

gat	gtc	gtg	ttc	gac	cat	aaa	ggc	ggc	gct	gac	ggc	acg	gaa	tgg	gtg	605
Asp	Val	Val	Phe	Asp	His	Lys	Gly	Gly	Ala	Asp	Gly	Thr	Glu	Trp	Val	
			105					110						115		

gac	gcc	gtc	gaa	gtc	aat	ccg	tcc	gac	cgc	aac	caa	gaa	atc	tcg	ggc	653
Asp	Ala	Val	Glu	Val	Asn	Pro	Ser	Asp	Arg	Asn	Gln	Glu	Ile	Ser	Gly	
			120					125					130			

acc	tat	caa	atc	caa	gca	tgg	acg	aaa	ttt	gat	ttt	ccc	ggg	cgg	ggc	701
Thr	Tyr	Gln	Ile	Gln	Ala	Trp	Thr	Lys	Phe	Asp	Phe	Pro	Gly	Arg	Gly	
		135					140					145				
aac	acc	tac	tcc	agc	ttt	aag	tgg	cgc	tgg	tac	cat	ttt	gac	ggc	gtt	749
Asn	Thr	Tyr	Ser	Ser	Phe	Lys	Trp	Arg	Trp	Tyr	His	Phe	Asp	Gly	Val	
	150					155					160					
gat	tgg	gac	gaa	agc	cga	aaa	ttg	agc	cgc	att	tac	aaa	ttc	cgc	ggc	797
Asp	Trp	Asp	Glu	Ser	Arg	Lys	Leu	Ser	Arg	Ile	Tyr	Lys	Phe	Arg	Gly	
165					170					175					180	
atc	ggc	aaa	gcg	tgg	gat	tgg	gaa	gta	gac	acg	gaa	aac	gga	aac	tat	845
Ile	Gly	Lys	Ala	Trp	Asp	Trp	Glu	Val	Asp	Thr	Glu	Asn	Gly	Asn	Tyr	
				185					190					195		
gac	tac	tta	atg	tat	gcc	gac	ctt	gat	atg	gat	cat	ccc	gaa	gtc	gtg	893
Asp	Tyr	Leu	Met	Tyr	Ala	Asp	Leu	Asp	Met	Asp	His	Pro	Glu	Val	Val	
			200					205					210			
acc	gag	ctg	aaa	aac	tgg	ggg	aaa	tgg	tat	gtc	aac	aca	acg	aac	att	941
Thr	Glu	Leu	Lys	Asn	Trp	Gly	Lys	Trp	Tyr	Val	Asn	Thr	Thr	Asn	Ile	
		215					220					225				
gat	ggg	ttc	cgg	ctt	gat	gcc	gtc	aag	cat	att	aag	ttc	agt	ttt	ttt	989
Asp	Gly	Phe	Arg	Leu	Asp	Ala	Val	Lys	His	Ile	Lys	Phe	Ser	Phe	Phe	
	230					235					240					
cct	gat	tgg	ttg	tcg	tat	gtg	cgt	tct	cag	act	ggc	aag	ccg	cta	ttt	1037
Pro	Asp	Trp	Leu	Ser	Tyr	Val	Arg	Ser	Gln	Thr	Gly	Lys	Pro	Leu	Phe	
245					250					255					260	
acc	gtc	ggg	gaa	tat	tgg	agc	tat	gac	atc	aac	aag	ttg	cac	aat	tac	1085
Thr	Val	Gly	Glu	Tyr	Trp	Ser	Tyr	Asp	Ile	Asn	Lys	Leu	His	Asn	Tyr	
				265					270					275		
att	acg	aaa	aca	gac	gga	acg	atg	tct	ttg	ttt	gat	gcc	ccg	tta	cac	1133
Ile	Thr	Lys	Thr	Asp	Gly	Thr	Met	Ser	Leu	Phe	Asp	Ala	Pro	Leu	His	
			280					285					290			
aac	aaa	ttt	tat	acc	gct	tcc	aaa	tca	ggg	ggc	gca	ttt	gat	atg	cgc	1181
Asn	Lys	Phe	Tyr	Thr	Ala	Ser	Lys	Ser	Gly	Gly	Ala	Phe	Asp	Met	Arg	
		295					300					305				
acg	tta	atg	acc	aat	act	ctc	atg	aaa	gat	caa	ccg	aca	ttg	gcc	gtc	1229
Thr	Leu	Met	Thr	Asn	Thr	Leu	Met	Lys	Asp	Gln	Pro	Thr	Leu	Ala	Val	
	310					315					320					
acc	ttc	gtt	gat	aat	cat	gac	acc	gaa	ccc	ggc	caa	gcg	ctg	cag	tca	1277
Thr	Phe	Val	Asp	Asn	His	Asp	Thr	Glu	Pro	Gly	Gln	Ala	Leu	Gln	Ser	
325					330					335					340	
tgg	gtc	gac	cca	tgg	ttc	aaa	ccg	ttg	gct	tac	gcc	ttt	att	cta	act	1325

F5

Trp	Val	Asp	Pro	Trp	Phe	Lys	Pro	Leu	Ala	Tyr	Ala	Phe	Ile	Leu	Thr	
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cg	ag	ga	gg	tac	ccg	tgc	gtc	ttt	tat	gg	gac	tat	tat	gg	att	1373
Arg	Gln	Glu	Gly	Tyr	Pro	Cys	Val	Phe	Tyr	Gly	Asp	Tyr	Tyr	Gly	Ile	
			360					365					370			
cca	caa	tat	aac	att	cct	tgc	ctg	aaa	agc	aaa	atc	gat	ccg	ctc	ctc	1421
Pro	Gln	Tyr	Asn	Ile	Pro	Ser	Leu	Lys	Ser	Lys	Ile	Asp	Pro	Leu	Leu	
		375					380					385				
atc	gcg	cgc	agg	gat	tat	gct	tac	gga	acg	caa	cat	gat	tat	ctt	gat	1469
Ile	Ala	Arg	Arg	Asp	Tyr	Ala	Tyr	Gly	Thr	Gln	His	Asp	Tyr	Leu	Asp	
	390					395					400					
cac	tcc	gac	atc	atc	ggg	tgg	aca	agg	gaa	ggg	ggc	act	gaa	aaa	cca	1517
His	Ser	Asp	Ile	Ile	Gly	Trp	Thr	Arg	Glu	Gly	Gly	Thr	Glu	Lys	Pro	
405					410					415					420	
gga	tcc	gga	ctg	gcc	gca	ctg	atc	acc	gat	ggg	ccg	gga	gga	agc	aaa	1565
Gly	Ser	Gly	Leu	Ala	Ala	Leu	Ile	Thr	Asp	Gly	Pro	Gly	Gly	Ser	Lys	
				425					430					435		
tgg	atg	tac	gtt	ggc	aaa	caa	cac	gct	gga	aaa	gtg	ttc	tat	gac	ctt	1613
Trp	Met	Tyr	Val	Gly	Lys	Gln	His	Ala	Gly	Lys	Val	Phe	Tyr	Asp	Leu	
			440					445					450			
acc	ggc	aac	cgg	agt	gac	acc	gtc	acc	atc	aac	agt	gat	gga	tgg	ggg	1661
Thr	Gly	Asn	Arg	Ser	Asp	Thr	Val	Thr	Ile	Asn	Ser	Asp	Gly	Trp	Gly	
		455					460					465				
gaa	ttc	aaa	gtc	aat	ggc	gg	tgc	gtt	tgc	gtt	tgg	gtt	cct	aga	aaa	1709
Glu	Phe	Lys	Val	Asn	Gly	Gly	Ser	Val	Ser	Val	Trp	Val	Pro	Arg	Lys	
	470					475					480					
acg	acc	gtt	tct	acc	atc	gct	cgg	ccg	atc	aca	acc	cga	ccg	tgg	act	1757
Thr	Thr	Val	Ser	Thr	Ile	Ala	Arg	Pro	Ile	Thr	Thr	Arg	Pro	Trp	Thr	
	485				490					495					500	
gg	gaa	ttc	gtc	cgt	tgg	acc	gaa	cca	cgg	ttg	gtg	gca	tgg	cct		1802
Gly	Glu	Phe	Val	Arg	Trp	Thr	Glu	Pro	Arg	Leu	Val	Ala	Trp	Pro		
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 <213> B. stearothermophilus

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 Ala Phe Leu Leu Thr Val Ser Leu Phe Cys Pro Thr Gly Gln Pro Ala

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Lys	Ala	Ala	Ala	Pro	Phe	Asn	Gly	Thr	Met	Met	Gln	Tyr	Phe	Glu	Trp		
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Tyr	Leu	Pro	Asp	Asp	Gly	Thr	Leu	Trp	Thr	Lys	Val	Ala	Asn	Glu	Ala		
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Asn	Asn	Leu	Ser	Ser	Leu	Gly	Ile	Thr	Ala	Leu	Trp	Leu	Pro	Pro	Ala		
65					70					75					80		
Tyr	Lys	Gly	Thr	Ser	Arg	Ser	Asp	Val	Gly	Tyr	Gly	Val	Tyr	Asp	Leu		
				85				90						95			
Tyr	Asp	Leu	Gly	Glu	Phe	Asn	Gln	Lys	Gly	Thr	Val	Arg	Thr	Lys	Tyr		
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Gly	Thr	Lys	Ala	Gln	Tyr	Leu	Gln	Ala	Ile	Gln	Ala	Ala	His	Ala	Ala		
		115					120					125					
Gly	Met	Gln	Val	Tyr	Ala	Asp	Val	Val	Phe	Asp	His	Lys	Gly	Gly	Ala		
	130					135					140						
Asp	Gly	Thr	Glu	Trp	Val	Asp	Ala	Val	Glu	Val	Asn	Pro	Ser	Asp	Arg		
145					150					155					160		
Asn	Gln	Glu	Ile	Ser	Gly	Thr	Tyr	Gln	Ile	Gln	Ala	Trp	Thr	Lys	Phe		
				165				170						175			
Asp	Phe	Pro	Gly	Arg	Gly	Asn	Thr	Tyr	Ser	Ser	Phe	Lys	Trp	Arg	Trp		
		180					185						190				
Tyr	His	Phe	Asp	Gly	Val	Asp	Trp	Asp	Glu	Ser	Arg	Lys	Leu	Ser	Arg		
		195					200					205					
Ile	Tyr	Lys	Phe	Arg	Gly	Ile	Gly	Lys	Ala	Trp	Asp	Trp	Glu	Val	Asp		
	210				215						220						
Thr	Glu	Asn	Gly	Asn	Tyr	Asp	Tyr	Leu	Met	Tyr	Ala	Asp	Leu	Asp	Met		
225				230						235					240		
Asp	His	Pro	Glu	Val	Val	Thr	Glu	Leu	Lys	Asn	Trp	Gly	Lys	Trp	Tyr		
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Val	Asn	Thr	Thr	Asn	Ile	Asp	Gly	Phe	Arg	Leu	Asp	Ala	Val	Lys	His		
			260				265						270				
Ile	Lys	Phe	Ser	Phe	Phe	Pro	Asp	Trp	Leu	Ser	Tyr	Val	Arg	Ser	Gln		
		275					280					285					
Thr	Gly	Lys	Pro	Leu	Phe	Thr	Val	Gly	Glu	Tyr	Trp	Ser	Tyr	Asp	Ile		
	290					295					300						
Asn	Lys	Leu	His	Asn	Tyr	Ile	Thr	Lys	Thr	Asp	Gly	Thr	Met	Ser	Leu		
305				310						315					320		
Phe	Asp	Ala	Pro	Leu	His	Asn	Lys	Phe	Tyr	Thr	Ala	Ser	Lys	Ser	Gly		
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Gly	Ala	Phe	Asp	Met	Arg	Thr	Leu	Met	Thr	Asn	Thr	Leu	Met	Lys	Asp		
		340					345					350					
Gln	Pro	Thr	Leu	Ala	Val	Thr	Phe	Val	Asp	Asn	His	Asp	Thr	Glu	Pro		
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Gly	Gln	Ala	Leu	Gln	Ser	Trp	Val	Asp	Pro	Trp	Phe	Lys	Pro	Leu	Ala		
	370					375					380						
Tyr	Ala	Phe	Ile	Leu	Thr	Arg	Gln	Glu	Gly	Tyr	Pro	Cys	Val	Phe	Tyr		
385				390						395					400		
Gly	Asp	Tyr	Tyr	Gly	Ile	Pro	Gln	Tyr	Asn	Ile	Pro	Ser	Leu	Lys	Ser		
				405				410						415			
Lys	Ile	Asp	Pro	Leu	Leu	Ile	Ala	Arg	Arg	Asp	Tyr	Ala	Tyr	Gly	Thr		
		420					425						430				
Gln	His	Asp	Tyr	Leu	Asp	His	Ser	Asp	Ile	Ile	Gly	Trp	Thr	Arg	Glu		
		435				440						445					
Gly	Gly	Thr	Glu	Lys	Pro	Gly	Ser	Gly	Leu	Ala	Ala	Leu	Ile	Thr	Asp		

450		455		460											
Gly	Pro	Gly	Gly	Ser	Lys	Trp	Met	Tyr	Val	Gly	Lys	Gln	His	Ala	Gly
465		470		475		480									
Lys	Val	Phe	Tyr	Asp	Leu	Thr	Gly	Asn	Arg	Ser	Asp	Thr	Val	Thr	Ile
		485		490		495									
Asn	Ser	Asp	Gly	Trp	Gly	Glu	Phe	Lys	Val	Asn	Gly	Gly	Ser	Val	Ser
		500		505		510									
Val	Trp	Val	Pro	Arg	Lys	Thr	Thr	Val	Ser	Thr	Ile	Ala	Arg	Pro	Ile
		515		520		525									
Thr	Thr	Arg	Pro	Trp	Thr	Gly	Glu	Phe	Val	Arg	Trp	Thr	Glu	Pro	Arg
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Leu	Val	Ala	Trp	Pro											
545															

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31

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36

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28

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Ala Asp Gln	Lys Tyr Cys Gly Gly Thr Trp Gln Gly Ile Ile Asp Lys		
	35	40	45
Leu Asp Tyr	Ile Gln Gly Met Gly Phe Thr Ala Ile Trp Ile Thr Pro		
	50	55	60
Val Thr Ala	Gln Leu Pro Gln Thr Thr Ala Tyr Gly Asp Ala Tyr His		
	65	70	75
Gly Tyr Trp	Gln Gln Asp Ile Tyr Ser Leu Asn Glu Asn Tyr Gly Thr		
	85	90	95
Ala Asp Asp	Leu Lys Ala Leu Ser Ser Ala Leu His Glu Arg Gly Met		
	100	105	110
Tyr Leu Met	Val Asp Val Val Ala Asn His Met Gly Tyr Asp Gly Ala		
	115	120	125
Gly Ser Ser	Val Asp Tyr Ser Val Phe Lys Pro Phe Ser Ser Gln Asp		
	130	135	140
Tyr Phe His	Pro Phe Cys Phe Ile Gln Asn Tyr Glu Asp Gln Thr Gln		
	145	150	155
Val Glu Asp	Cys Trp Leu Gly Asp Asn Thr Val Ser Leu Pro Asp Leu		
	165	170	175
Asp Thr Thr	Lys Asp Val Val Lys Asn Glu Trp Tyr Asp Trp Val Gly		
	180	185	190
Ser Leu Val	Ser Asn Tyr Ser Ile Asp Gly Leu Arg Ile Asp Thr Val		
	195	200	205
Lys His Val	Gln Lys Asp Phe Trp Pro Gly Tyr Asn Lys Ala Ala Gly		
	210	215	220
Val Tyr Cys	Ile Gly Glu Val Leu Asp Gly Asp Pro Ala Tyr Thr Cys		
	225	230	235
Pro Tyr Gln	Asn Val Met Asp Gly Val Leu Asn Tyr Pro Ile Tyr Tyr		
	245	250	255
Pro Leu Leu	Asn Ala Phe Lys Ser Thr Ser Gly Ser Met Asp Asp Leu		
	260	265	270
Tyr Asn Met	Ile Asn Thr Val Lys Ser Asp Cys Pro Asp Ser Thr Leu		
	275	280	285
Leu Gly Thr	Phe Val Glu Asn His Asp Asn Pro Arg Phe Ala Ser Tyr		
	290	295	300
Thr Asn Asp	Ile Ala Leu Ala Lys Asn Val Ala Ala Phe Ile Ile Leu		
	305	310	315
Asn Asp Gly	Ile Pro Ile Ile Tyr Ala Gly Gln Glu Gln His Tyr Ala		
	325	330	335
Gly Gly Asn	Asp Pro Ala Asn Arg Glu Ala Thr Trp Leu Ser Gly Tyr		
	340	345	350
Pro Thr Asp	Ser Glu Leu Tyr Lys Leu Ile Ala Ser Ala Asn Ala Ile		
	355	360	365
Arg Asn Tyr	Ala Ile Ser Lys Asp Thr Gly Phe Val Thr Tyr Lys Asn		
	370	375	380
Trp Pro Ile	Tyr Lys Asp Asp Ile Thr Ile Ala Met Arg Lys Gly Thr		
	385	390	395
Asp Gly Ser	Gln Ile Val Thr Ile Leu Ser Asn Lys Gly Ala Ser Gly		
	405	410	415
Asp Ser Tyr	Thr Leu Ser Leu Ser Gly Ala Gly Tyr Thr Ala Gly Gln		
	420	425	430
Gln Leu Thr	Glu Val Ile Gly Cys Thr Thr Val Thr Val Gly Ser Asp		

F5

		435					440					445			
Gly	Asn	Val	Pro	Val	Pro	Met	Ala	Gly	Gly	Leu	Pro	Arg	Val	Leu	Tyr
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His	His	Asn	Gly	Thr	Asn	Gly	Thr	Met	Met	Gln	Tyr	Phe	Glu	Trp	Tyr		
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ttg	cca	aat	gac	ggg	aat	cat	tgg	aac	agg	ttg	agg	gat	gac	gca	gct		96
Leu	Pro	Asn	Asp	Gly	Asn	His	Trp	Asn	Arg	Leu	Arg	Asp	Asp	Ala	Ala		
			20					25					30				
aac	tta	aag	agt	aaa	ggg	ata	aca	gct	gta	tgg	atc	cca	cct	gca	tgg		144
Asn	Leu	Lys	Ser	Lys	Gly	Ile	Thr	Ala	Val	Trp	Ile	Pro	Pro	Ala	Trp		
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aag	ggg	act	tcc	cag	aat	gat	gta	ggg	tat	gga	gcc	tat	gat	tta	tat		192
Lys	Gly	Thr	Ser	Gln	Asn	Asp	Val	Gly	Tyr	Gly	Ala	Tyr	Asp	Leu	Tyr		
	50					55					60						
gat	ctt	gga	gag	ttt	aac	cag	aag	ggg	acg	gtt	cgt	aca	aaa	tat	gga		240
Asp	Leu	Gly	Glu	Phe	Asn	Gln	Lys	Gly	Thr	Val	Arg	Thr	Lys	Tyr	Gly		
65					70					75					80		
aca	cgc	aac	cag	cta	cag	gct	gcg	gtg	acc	tct	tta	aaa	aat	aac	ggc		288
Thr	Arg	Asn	Gln	Leu	Gln	Ala	Ala	Val	Thr	Ser	Leu	Lys	Asn	Asn	Gly		
				85				90						95			
att	cag	gta	tat	ggg	gat	gtc	gtc	atg	aat	cat	aaa	ggg	gga	gca	gat		336
Ile	Gln	Val	Tyr	Gly	Asp	Val	Val	Met	Asn	His	Lys	Gly	Gly	Ala	Asp		
			100					105					110				
ggg	acg	gaa	att	gta	aat	gcg	gta	gaa	gtg	aat	cgg	agc	aac	cga	aac		384
Gly	Thr	Glu	Ile	Val	Asn	Ala	Val	Glu	Val	Asn	Arg	Ser	Asn	Arg	Asn		
		115					120					125					
cag	gaa	acc	tca	gga	gag	tat	gca	ata	gaa	gcg	tgg	aca	aag	ttt	gat		432
Gln	Glu	Thr	Ser	Gly	Glu	Tyr	Ala	Ile	Glu	Ala	Trp	Thr	Lys	Phe	Asp		
	130					135					140						
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Phe	Pro	Gly	Arg	Gly	Asn	Asn	His	Ser	Ser	Phe	Lys	Trp	Arg	Trp	Tyr		



145	150	155	160	
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His Phe Asp Gly Thr Asp Trp Asp Gln Ser Arg Gln Leu Gln Asn Lys				
165 170 175				
ata tat aaa ttc agg gga aca ggc aag gcc tgg gac tgg gaa gtc gat	576			
Ile Tyr Lys Phe Arg Gly Thr Gly Lys Ala Trp Asp Trp Glu Val Asp				
180 185 190				
aca gag aat ggc aac tat gat tat ctt atg tat gca gac gtg gat atg	624			
Thr Glu Asn Gly Asn Tyr Asp Tyr Leu Met Tyr Ala Asp Val Asp Met				
195 200 205				
gat cac cca gaa gta ata cat gaa ctt aga aac tgg gga gtg tgg tat	672			
Asp His Pro Glu Val Ile His Glu Leu Arg Asn Trp Gly Val Trp Tyr				
210 215 220				
acg aat aca ctg aac ctt gat gga ttt aga ata gat gca gtg aaa cat	720			
Thr Asn Thr Leu Asn Leu Asp Gly Phe Arg Ile Asp Ala Val Lys His				
225 230 235 240				
ata aaa tat agc ttt acg aga gat tgg ctt aca cat gtg cgt aac acc	768			
Ile Lys Tyr Ser Phe Thr Arg Asp Trp Leu Thr His Val Arg Asn Thr				
245 250 255				
aca ggt aaa cca atg ttt gca gtg gct gag ttt tgg aaa aat gac ctt	816			
Thr Gly Lys Pro Met Phe Ala Val Ala Glu Phe Trp Lys Asn Asp Leu				
260 265 270				
ggt gca att gaa aac tat ttg aat aaa aca agt tgg aat cac tcg gtg	864			
Gly Ala Ile Glu Asn Tyr Leu Asn Lys Thr Ser Trp Asn His Ser Val				
275 280 285				
ttt gat gtt cct ctc cac tat aat ttg tac aat gca tct aat agc ggt	912			
Phe Asp Val Pro Leu His Tyr Asn Leu Tyr Asn Ala Ser Asn Ser Gly				
290 295 300				
ggt tat tat gat atg aga aat att tta aat ggt tct gtg gtg caa aaa	960			
Gly Tyr Tyr Asp Met Arg Asn Ile Leu Asn Gly Ser Val Val Gln Lys				
305 310 315 320				
cat cca aca cat gcc gtt act ttt gtt gat aac cat gat tct cag ccc	1008			
His Pro Thr His Ala Val Thr Phe Val Asp Asn His Asp Ser Gln Pro				
325 330 335				
ggg gaa gca ttg gaa tcc ttt gtt caa caa tgg ttt aaa cca ctt gca	1056			
Gly Glu Ala Leu Glu Ser Phe Val Gln Gln Trp Phe Lys Pro Leu Ala				
340 345 350				
tat gca ttg gtt ctg aca agg gaa caa ggt tat cct tcc gta ttt tat	1104			
Tyr Ala Leu Val Leu Thr Arg Glu Gln Gly Tyr Pro Ser Val Phe Tyr				
355 360 365				

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Gly Asp Tyr Tyr Gly Ile Pro Thr His Gly Val Pro Ala Met Lys Ser	
370 375 380	
aaa ata gac cct ctt ctg cag gca cgt caa act ttt gcc tat ggt acg	1200
Lys Ile Asp Pro Leu Leu Gln Ala Arg Gln Thr Phe Ala Tyr Gly Thr	
385 390 395 400	
cag cat gat tac ttt gat cat cat gat att atc ggt tgg aca aga gag	1248
Gln His Asp Tyr Phe Asp His His Asp Ile Ile Gly Trp Thr Arg Glu	
405 410 415	
gga aat agc tcc cat cca aat tca ggc ctt gcc acc att atg tca gat	1296
Gly Asn Ser Ser His Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asp	
420 425 430	
ggg cca ggt ggt aac aaa tgg atg tat gtg ggg aaa aat aaa gcg gga	1344
Gly Pro Gly Gly Asn Lys Trp Met Tyr Val Gly Lys Asn Lys Ala Gly	
435 440 445	
caa gtt tgg aga gat att acc gga aat agg aca ggc acc gtc aca att	1392
Gln Val Trp Arg Asp Ile Thr Gly Asn Arg Thr Gly Thr Val Thr Ile	
450 455 460	
aat gca gac gga tgg ggt aat ttc tct gtt aat gga ggg tcc gtt tcg	1440
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Val Trp Val Lys Gln	
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 Asn Leu Lys Ser Lys Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Trp  
 35 40 45  
 Lys Gly Thr Ser Gln Asn Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr  
 50 55 60  
 Asp Leu Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly  
 65 70 75 80  
 Thr Arg Asn Gln Leu Gln Ala Ala Val Thr Ser Leu Lys Asn Asn Gly  
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 Ile Gln Val Tyr Gly Asp Val Val Met Asn His Lys Gly Gly Ala Asp  
 100 105 110  
 Gly Thr Glu Ile Val Asn Ala Val Glu Val Asn Arg Ser Asn Arg Asn

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Ile	Tyr	Lys	Phe	Arg	Gly	Thr	Gly	Lys	Ala	Trp	Asp	Trp	Glu	Val	Asp		
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Lys	Ile	Asp	Pro	Leu	Leu	Gln	Ala	Arg	Gln	Thr	Phe	Ala	Tyr	Gly	Thr		
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Gln	His	Asp	Tyr	Phe	Asp	His	His	Asp	Ile	Ile	Gly	Trp	Thr	Arg	Glu		
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Gly	Asn	Ser	Ser	His	Pro	Asn	Ser	Gly	Leu	Ala	Thr	Ile	Met	Ser	Asp		
			420					425					430				
Gly	Pro	Gly	Gly	Asn	Lys	Trp	Met	Tyr	Val	Gly	Lys	Asn	Lys	Ala	Gly		
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Gln	Val	Trp	Arg	Asp	Ile	Thr	Gly	Asn	Arg	Thr	Gly	Thr	Val	Thr	Ile		
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<400> 13

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Ile	Gly	Ile	Thr	Ala	Val	Trp	Ile	Pro	Pro	Ala	Tyr	Lys	Gly	Leu	Ser	
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Gln	Ser	Asp	Asn	Gly	Tyr	Gly	Pro	Tyr	Asp	Leu	Tyr	Asp	Leu	Gly	Glu	
	50					55					60					
Phe	Gln	Gln	Lys	Gly	Thr	Val	Arg	Thr	Lys	Tyr	Gly	Thr	Lys	Ser	Glu	
65					70					75					80	
Leu	Gln	Asp	Ala	Ile	Gly	Ser	Leu	His	Ser	Arg	Asn	Val	Gln	Val	Tyr	
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Gly	Asp	Val	Val	Leu	Asn	His	Lys	Ala	Gly	Ala	Asp	Ala	Thr	Glu	Asp	
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Tyr	Asp	Tyr	Leu	Met	Tyr	Ala	Asp	Val	Asp	Tyr	Asp	His	Pro	Asp	Val	
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Phe	Thr	Val	Ala	Glu	Tyr	Trp	Gln	Asn	Asn	Ala	Gly	Lys	Leu	Glu	Asn	
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Tyr	Leu	Asn	Lys	Thr	Ser	Phe	Asn	Gln	Ser	Val	Phe	Asp	Val	Pro	Leu	
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His	Phe	Asn	Leu	Gln	Ala	Ala	Ser	Ser	Gln	Gly	Gly	Gly	Tyr	Asp	Met	
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Arg	Lys	Leu	Leu	Asn	Gly	Thr	Val	Val	Ser	Lys	His	Pro	Leu	Lys	Ser	
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Val	Thr	Phe	Val	Asp	Asn	His	Asp	Thr	Gln	Pro	Gly	Gln	Ser	Leu	Glu	
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Ser	Thr	Val	Gln	Thr	Trp	Phe	Lys	Pro	Leu	Ala	Tyr	Ala	Phe	Ile	Leu	
			340					345					350			
Thr	Arg	Glu	Ser	Gly	Tyr	Pro	Gln	Val	Phe	Tyr	Gly	Asp	Met	Tyr	Gly	
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Thr	Lys	Gly	Asp	Ser	Gln	Arg	Glu	Ile	Pro	Ala	Leu	Lys	His	Lys	Ile	
	370					375					380					
Glu	Pro	Ile	Leu	Lys	Ala	Arg	Lys	Gln	Tyr	Ala	Tyr	Gly	Ala	Gln	His	
385					390					395					400	
Asp	Tyr	Phe	Asp	His	His	Asp	Ile	Val	Gly	Trp	Thr	Arg	Glu	Gly	Asp	
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Ser	Ser	Val	Ala	Asn	Ser	Gly	Leu	Ala	Ala	Leu	Ile	Thr	Asp	Gly	Pro	
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F5

Gly	Gly	Ala	Lys	Arg	Met	Tyr	Val	Gly	Arg	Gln	Asn	Ala	Gly	Glu	Thr
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Trp	His	Asp	Ile	Thr	Gly	Asn	Arg	Ser	Glu	Pro	Val	Val	Ile	Asn	Ser
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Ile Pro Thr His Gly Val  
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<400> 16

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